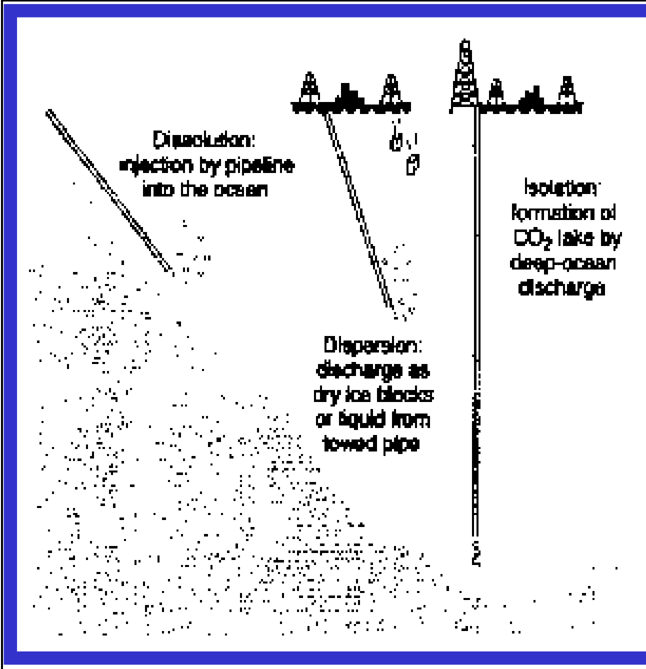
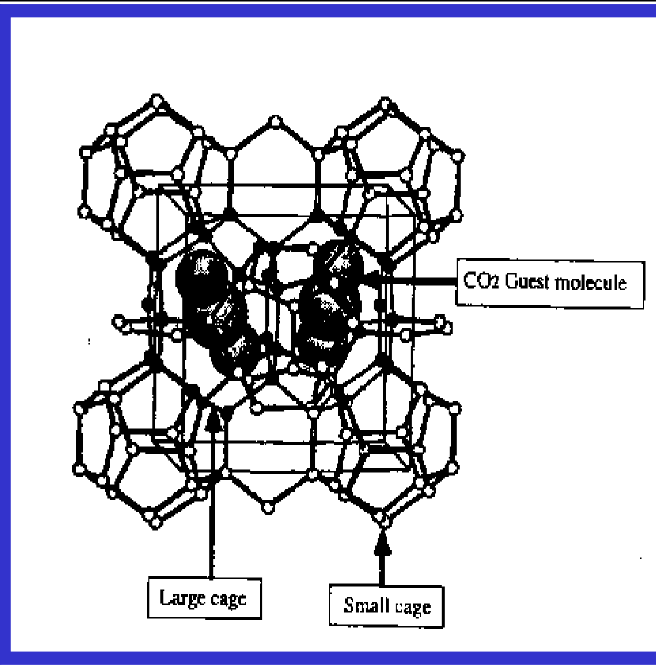
3.3 OCEAN SEQUESTRATION

3.3.1 OCEAN SEQUESTRATION – DIRECT INJECTION

Technology Description





Sketch of various ocean CO_2 disposal options (left). Structure of a CO_2 hydrate (right).

Ocean sequestration technologies strive to reduce carbon emissions by injecting captured CO_2 into the ocean, rather than releasing it into the atmosphere. The captured CO_2 is concentrated, and then pressurized into a liquid state. The physical chemistry of CO_2 is such that at high pressure and low temperatures (which exist at depth in the ocean), the CO_2 molecule reacts with seawater wrapping itself in a cage of water to form a solid compound much like ice (clathrate). This reaction profoundly changes its behavior. However, there are significant environmental questions that need to be examined.

System Concepts

- CO_2 is captured from a large point source of anthropogenic emissions production, transported, and injected into the ocean via pipeline or tanker.
- CO_2 molecules react with seawater wrapping themselves in cages of water to form solid compounds, much like ice (clathrates).

Representative Technologies

- Technologies will potentially be borrowed from the petroleum industry in the areas of drilling simulation and wells; processing, compression, and pipeline transport of gases; and operational experience of CO_2 injection.

Technology Status/Applications

- The injection technology is technically ready for adaptation for mid- to deep-ocean injection. However, technology is not ready for deployment. This is due to insufficient data detailing hydrate interactions with marine community structure, as well as knowledge gaps about physical and chemical behavior concerning dispersion and transport of hydrate plume by ocean chemistry and circulation.

Current Research, Development, and Demonstration

RD&D Goals

- Demonstrate that CO_2 direct injection is safe and environmentally acceptable.
- Improve global circulation simulation by including more accurate biology modules.

RD&D Challenges

- Develop field practices that optimize CO_2 direct-injection retention times.
- Develop the ability to predict plume effects on marine organisms.
- Develop the ability to track the fate of directly injected CO_2.
- Develop a better understanding of the CO_2 chemistry in ocean waters, and its effects on indigenous organisms, e.g. hypercapnia (effects of elevated CO_2 levels), and acidification of plume waters (depressed pH).

RD&D Activities

- Key DOE activities are targeted to determine physical, chemical, and biological impacts of direct injection.
- Conduct an appropriate-scale field experiment to adequately assess unit operations and potential impacts on marine environment at a sufficient scale downstream of injection zone.
- Formulate future experiments to evaluate ecological community effects (long term) and the total impact on the ecology of multiple regions of deep oceans.
- Develop other small-scale field experiments to understand fundamental biogeochemical cycles**.**
- Current expenditures for field experiment estimated to be $6 million.

Recent Progress

- A survey cruise of Hawaiian biology occurred during the summer of 1999.
- Small-scale release (one liter) at 3,600 m off the California coast demonstrating hydrate formation.
- Properties of hydrate formation determined in lab utilizing high-pressure, low-temperature reaction vessels.
- Conducted 10-day cruise off Loihi seamount (Hawaii) during December 2002, to determine effect of natural analogues of CO_2 on amphipod community in vent waters**.**
- Measured *in situ* penetration of added CO_2 into the seabed at 3,200 m depth (2004-2005)